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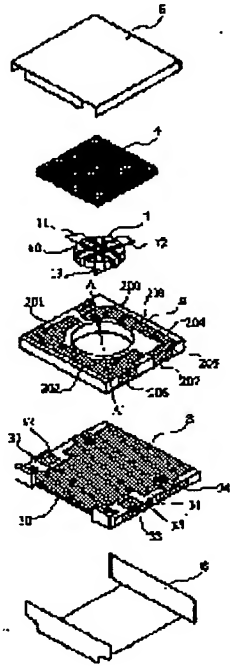
(54) NONREVERSIBLE CIRCUIT ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a nonreversible circuit element which attains insertion loss reduction and miniaturization and is surface-mountable.
SOLUTION: A nonreversible circuit element having a central conductor assembly 1 with central conductors 11, 12 and 13 insulated with a garnet 10, a capacitive substrate 2 with accommodates the central conductor assembly 1 inside a recessed hole 200 formed almost in the center and which is electrically connected to the assembly and a permanent magnet 4 for applying a DC magnetic field are all housed in a metallic cases 5 and 6 that also function as magnetic yokes. The capacitive substrate 2 is formed by laminated and sintered material and the heights of the connecting electrode part of the capacitive substrate 2 and the central conductor assembly 1 are set almost equal for connecting one terminal of the central conductor of the central conductor assembly 1 to the connecting electrode part of the capacitive substrate.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The non-reciprocal circuit element which is equipped with the following, forms the aforementioned capacitative-element substrate with a laminating sintering object in the non-reciprocal circuit element which comes to arrange these in the metal vertical case which serves as a magnetic yoke, and is characterized by for the polar-zone height of a capacitative-element substrate to be the same height mostly to the height of the aforementioned central conductor assembly in order to connect to the polar zone of the aforementioned capacitative-element substrate the end of the central conductor of the central conductor assembly contained in the aforementioned hollow. The central conductor assembly which has the central conductor which maintained the ferrite, and this ferrite and an insulating state, and has been arranged. The capacitative-element substrate which held the aforementioned central conductor assembly in the hollow formed in the center of abbreviation, and was electrically connected with the central conductor assembly. The permanent magnet which impresses a direct-current magnetic field to the aforementioned central conductor assembly.
[Claim 2] The non-reciprocal circuit element according to claim 1 characterized by the difference of the polar zone of the aforementioned capacitative-element substrate and the height of a central conductor being 0.3mm or less.
[Claim 3] The non-reciprocal circuit element according to claim 1 or 2 to which a central conductor is characterized by being formed by the conductor on an insulation sheet.
[Claim 4] A non-reciprocal circuit element given in the claim 1 or any of 3 they are. [which is characterized by forming the aforementioned central conductor assembly by the ceramic layered product by the dielectric or the magnetic substance]
[Claim 5] A non-reciprocal circuit element given in the claim 1 or any of 4 they are. [which is characterized by arranging the resin base which unified the conductor board and the resin frame between the aforementioned capacitative-element substrate and a lower metal case, and having prepared the polar zone for connecting with an external mounting substrate on the resin frame lateral surface and/or base of this resin base in it]

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] About the non-reciprocal circuit element which has an irreversible transmission characteristic to a RF signal, this invention is specifically used in mobile communication system, such as a cellular phone, and relates to the non-reciprocal circuit element generally called an isolator and circulator.
[0002]
[Description of the Prior Art] A non-reciprocal circuit element is a circuit element transmitted to the central conductor of the specific direction, without attenuating the signal which two or more central conductors were made to intersect ferrites, such as a garnet, prepared, added the direct-current magnetic field to the ferrite with the magnet, was made to produce magnetic-resonance rotating magnetic field in a ferrite, and was inputted into a certain central conductor. For example, although most signals of the specific direction are passed between other two central conductors by an isolator's making three central conductors cross and using one as nonreflective termination inside, without making it decrease, the signal of an opposite direction is the non-reciprocal circuit element which gave a property which is attenuated greatly. Such a non-reciprocal circuit element is used for a mobile transmitter, a portable telephone, etc., and is an indispensable circuit element for operational stability of removal of the reflected wave within the transmitting section and a receive section, impedance matching, amplifier, VCO, etc., etc. Taking the case of a concentrated-constant type isolator, it explains below.
[0003] The decomposition perspective diagram of the conventional isolator is shown in drawing 4 . According to this example, a grounded plate 64 is arranged on the metal lower case 63, and the capacitative-element substrate 40 is arranged on it. This capacitative-element substrate 40 consists of one dielectric substrate, and has the through hole 41 in the center. The electrode patterns 43, 44, and 45 which constitute capacitative element are formed in the upper surface of this capacitative-element substrate 40, respectively, it crosses to a rear face mostly on the whole surface, the ground pattern is formed, and resonance capacity has been obtained between the electrode pattern on top and the ground pattern. this electrode pattern for capacitative element -- one 45 is connected to a dummy resistor 46, and the dummy resistor 46 is further connected to the ground electrode 47 This ground electrode 47 is connected to a grounded plate 64 by the through hole 49. The central conductor assembly 55 is arranged at the through hole 41 of this capacitative-element substrate 40. This central conductor assembly 55 has the central conductors 56, 57, and 58 inserted into the radial at intervals of 120 degrees so that the ferrite disks 50, such as a garnet, may be wrapped, and it insulates between each central conductor. And the metal upper case 61 which the permanent magnet 53 pasted up on the upper part is established, and the upper case 61 and the lower case 63 are inserted in, and it is assembled. The end section of central conductors 57 and 58 is pulled out by 62 between upper case 61 and lower cases 63 partial shell exterior, and constitutes the input/output terminal here.
[0004]
[Problem(s) to be Solved by the Invention] In the above-mentioned conventional example, when it miniaturizes an isolator further, the size of a capacitor must be made small, the diameter of a

garnet must be made small, or both must be made small. The capacity of a capacitor is expressed as C=epsilon r-epsilon 0.S/d. In the specific inductive capacity of a dielectric, and epsilon 0, the dielectric constant of vacuum and S express the area of an electrode, and d expresses [the capacity and epsilonr whose C is a capacitor here] the thickness of an inter-electrode dielectric. Even if it makes area S of an electrode small by making the size of a capacitor small, in order to obtain the same capacity, you have to make thickness of an inter-electrode dielectric thin, using the large dielectric of specific-inductive-capacity epsilonr. However, since the insertion loss of an isolator will become large if dielectric loss also has a large inclination and dielectric loss is generally large, the dielectric materials with large specific inductive capacity are not desirable. If thickness of a dielectric is made thin, the level difference of the upper surface of a garnet and the upper surface of a capacitative-element substrate will become large. A crevice occurs between a central conductor 58 and the capacity pattern 44 in a manufacturing process by this, and it becomes easy to generate the state which has not been connected electrically and open [so-called / poor]. Moreover, since the size of the space made between a central conductor 58, a garnet 50, and the capacitative-element substrate 40 varies in a manufacturing process even if it has connected electrically, this serves as dispersion in an impedance and serves as a cause of dispersion in the insertion loss and frequency of operation of an isolator, or an input impedance.

[0005] Moreover, although there is also the method of bending the end of a central conductor so that the side of a garnet may be met of performing the so-called foaming as shown in 58a of drawing 5 in order to make such unnecessary space small as much as possible and to make small the crevice between a central conductor and a capacity pattern, since a process increases, cost becomes high. Moreover, dispersion in the bending angle of the central conductor for foaming in a manufacturing process serves as a cause of dispersion in the insertion loss and frequency of operation of an isolator, or an input impedance like ****. Moreover, if solder is stiffened in the state where a central conductor assembly tended to incline and it inclined when the uneven force took after inserting a central conductor assembly in a capacity substrate element in the middle of solder hardening in the manufacturing process at the central conductor assembly, the insertion loss of an isolator will increase and a frequency of operation will shift. Moreover, in the design which a magnet meets with that there is no crevice in a central conductor assembly, dispersion in the parallelism of a magnet and a garnet becomes large, and serves as a cause of property dispersion of an isolator.

[0006] Since the inductance of a central conductor and the central conductor assembly which consists of garnets becomes small on the other hand when making the diameter of a garnet small, since an isolator is miniaturized, you have to enlarge capacity of a capacitor, in order to make it the same frequency of operation. For this reason, the same problem as the case where the size of the capacitor of point ** is made small occurs. Moreover, although the inductance of a central conductor assembly can be enlarged if thickness of a garnet is thickened, since the upper surface of a garnet and the level difference of a capacitative-element substrate become large, this is not desirable, either. Moreover, in the above-mentioned conventional example, it is not suitable for the miniaturization instead of the structure in which surface mounting is possible.

[0007] From the above thing, this invention aims at reduction of open [poor] and property dispersion, and raises the yield, and it aims at attaining low-cost-ization and offering the non-reciprocal circuit element formed into the small low back by considering as the structure in which surface mounting is still more possible.

[0008]

[Means for Solving the Problem] The central conductor assembly which has the central conductor which this invention maintained the ferrite, and this ferrite and an insulating state, and has been arranged, The capacitative-element substrate which held the aforementioned central conductor assembly in the hollow formed in the center of abbreviation, and was electrically connected with the central conductor assembly, In the non-reciprocal circuit element which has the permanent magnet which impresses a direct-current magnetic field to the aforementioned central conductor assembly, and comes to arrange these in the metal vertical case which serves

as a magnetic yoke In order to connect to the polar zone of the aforementioned capacitative-element substrate the end of the central conductor of the central conductor assembly which formed the aforementioned capacitative-element substrate with the laminating sintering object, and was contained in the aforementioned hollow, it is the non-reciprocal circuit element whose polar-zone height of a capacitative-element substrate is the same height mostly to the height of the aforementioned central conductor assembly.

[0009] Here, it is more desirable for the difference of the polar zone of a capacitative-element substrate and the height of a central conductor to be 0.3mm or less, and a central conductor may be formed by the conductor on an insulation sheet. Moreover, a central conductor assembly can also form by the ceramic layered product by the dielectric or the magnetic substance. Moreover, it is desirable to use the resin base which arranges the resin base which unified a conductor board and resin frames, such as a copper plate, between the capacitative-element substrate and the lower metal case, and the polar zone for connecting with an external mounting substrate has established in the resin frame lateral surface and/or base of this resin base.

[0010] In this invention, the capacitative-element substrate was first made into the layered product structure of a sintered type really which carried out the laminating of the green sheet and sintered it. The capacitor of high capacity and low loss can be obtained in a small area, without using high dielectric constant material with comparatively large dielectric loss by this. in addition -- and by carrying out the laminating of the dummy layer which does not contribute to capacitor capacity substantially simultaneously, the thickness of a capacitative-element substrate can be designed so that the height of a central conductor assembly may be suited Consequently, the upper surface electrode of a central conductor assembly and a capacitative-element substrate can be constituted almost flat-tapped, and each can connect three central conductors uniformly using the short paddle stripline of the same length. Moreover, insertion of a central conductor can be performed correctly. Therefore, the variation in an insertion loss, a frequency of operation, or an input impedance also became few. Moreover, the resin base is equipped with an input/output terminal and a grounded plate with the thin electric conduction board linked to a capacitative-element substrate, and it is united with the external electrode of the geometry which was respectively suitable for surface mounting. These electrodes are firmly maintained by the resin frame of right-and-left ends. Therefore, grounding and I/O connection by installation of a up to [a mounting substrate] will become certain and easy. Moreover, as compared with the case where an immediate external terminal is formed in a layered product, it excels in the solder-proof foods crack nature of an external terminal, and a sticking tendency, and a reliable isolator can be offered.

[0011]

[Embodiments of the Invention] Hereafter, the example of the non-reciprocal circuit element of this invention is explained with reference to a drawing. Drawing 2 whose drawing 1 is the decomposition perspective diagram showing one example of the non-reciprocal circuit element of this invention is the decomposition perspective diagram of a capacitative-element substrate. Drawing 3 is partial drawing of longitudinal section of a non-reciprocal circuit element. This non-reciprocal circuit element from drawing 1 so that the aforementioned central conductor assembly 1 may be included in the through hole of the central conductor assembly 1 and a center section First, nothing, As well as the capacitative-element substrate 2 which has the resistor formed in the upper surface by the I/O electrode or the resistance film, the permanent magnet 4 which impresses a direct-current magnetic field to the central conductor assembly 1, and the metal upper case 5 which serves both as a magnetic yoke, between the lower case 6, and the capacitative-element substrate 2 and the lower case 6 It consists of the resin base 3 which incorporated the electric conduction boards 30, 32, and 33, such as a dovetail Cu board, into the resin frame 31. The resin base 3 fits into the metal part of the center section of the lower case 6, and the resin frame 31 on either side faces the mounting substrate side so that surface mounting may be possible. That is, the electrode (not shown) which counters 34 and it among four external electrodes in the right-and-left edge of the resin base 3 flows with the electric conduction board 30, and serves as a grounding terminal. It has connected with the terminals 33 and 32 respectively connected with the terminal electrode (not shown) formed in the rear face of

capacitative element to which a central conductor is connected, the external electrode 35 and the electrode (not shown) which counters it serve as an input/output terminal, and surface mounting is carried out to a mounting substrate. Grounding and I/O connection by installation of a up to [a mounting substrate] will become certain and easy with the resin base 3. Moreover, as compared with the case where an immediate external terminal is formed in a layered product, it excels in the solder-proof foods crack nature of an external terminal, and a sticking tendency, and a reliable isolator can be offered.

[0012] 120 degrees, the central conductor assembly 1 is an interval, and weaves in the central conductors 11, 12, and 13 which become the ferrites 10, such as a garnet, from three striplines as usual through an insulator. For example, as shown in drawing 3 , the end 132 of a central conductor 13 is soldered to the electric conduction board 30 of a resin case by the inferior-surface-of-tongue side of a garnet, and has connected the electric conduction board 30 to the lower case 6. Already, an end 131 is in the upper surface, extends to a radial, and serves as an output electrode. Other central conductors are the same and constitute the input electrode and the load electrode. The so-called foaming process which the terminal by the side of these upper surfaces is only what was extended linearly, and bends the ends 11, 12, and 13 of a central conductor so that the side of a garnet may be met further is unnecessary. In addition, a central conductor can also use what was formed by conductors, such as copper foil, on insulation sheets, such as an organic resin, and the thing formed by the layered product by the dielectric or the magnetic substance, can assemble it by this, can cut down a man day, and can also measure cost reduction further. Moreover, the laminating of the green sheet of the magnetic substance can be carried out, the central conductor assembly 1 whole can also be formed, and according to this, a central conductor assembly can be further made thin.

[0013] Next, the capacitative-element substrate 2 consists of a laminating sintering object of one apparatus which carried out the laminating of the dielectric green sheet, it has a through hole 200 in a center section, and the input-capacitance electrode 201, the output-capacitance electrode 202, the load electrode 203 and the ground electrode 205, and terminator 204 for forming the capacitor for adjustment are formed in the upper surface by printing. The side electrode (not shown) in the side electrodes 206 and 207 which connect the electrode on the upper surface of a substrate, an internal electrode, and the electrode on the rear face of a substrate, and these counter electrodes is prepared in the lateral surface of the capacitative-element substrate 2. In the rear face of a capacitative-element substrate, a ground electrode is mostly prepared in the whole surface, and the input/output terminal linked to the terminal electrodes 32 and 33 by the side of the resin base 3 is prepared in both ends. And resonance capacity is obtained between an I/O electrode or a load electrode, and a ground electrode. The electric conduction board to which the end of each central conductors 11, 12, and 13 is connected under the garnet after manufacturing separately the above-mentioned central conductor assembly 1 and the capacitative-element substrate 2, respectively and carrying out fitting wearing of the central conductor assembly 1 into the through hole 200 of the capacitative-element substrate 2 is connected to the ground electric conduction board 30, and the other end is electrically connected to the upper surface electrodes 201, 202, and 203 of the capacitative-element substrate 2 with soldering, respectively. At this time, since the height of the central conductor assembly 1 and the capacitative-element substrate 2 is set up almost identically, it can connect the end 131 of the stripline prolonged in the shape of a straight line as shown in drawing 3 that there is no crevice on an electrode 206. Therefore, dispersion in an assembly is reduced and it came to be able to do correctly.

[0014] Next, the decomposition perspective diagram showing the capacitative-element substrate 2 in drawing 2 explains. The capacitative-element substrate 2 of this example is multilayer structure which consists of the 1st, the 2nd, the 3rd, the 4th, and 5th dielectric layers 2a, 2b, 2c, 2d, and 2e. the 1- which made glass the principal component first -- the green sheet for 5th dielectric-layer 2a - 2e is produced in a doctor blade method, and a through hole is opened in a position On the green sheet of 1st dielectric-layer 2a, 1st input-capacitance electrode 21a, 1st output-capacitance electrode 22a, 1st load capacity electrode 23a, and grounding-electrode 26a are printed by electric conduction material, such as a silver paste, so that a predetermined

adjustment capacity may be obtained. Moreover, through hole 24a is formed in electrode 23a. Grand electrode 200b is formed on the green sheet of 2nd dielectric-layer 2b. Moreover, through hole 24b is formed in the position which carries out correspondence agreement with through hole 24of 1st dielectric-layer 2a a. On the green sheet of 3rd dielectric-layer 2c, 2nd input-capacitance electrode 21c, 2nd output-capacitance electrode 22c, and 2nd load capacity electrode 23c are printed similarly, and printing formation of the 200d of the grand electrodes is carried out like the 2nd dielectric layer on the green sheet of the 2d of the 4th dielectric layer. On it, the electrode is not printed for 5th dielectric-layer 2e by the green sheet of a dummy.
[0015] Subsequently, the laminating of the green sheet of the 1st - the 5th dielectric layer 2a-2e is carried out one by one, it carries out thermocompression bonding, and the layered product of one apparatus is obtained. The through hole 20 into which the central conductor assembly 1 should fit is pierced and formed in the obtained layered product. Then, a layered product is cut in a predetermined size and it calcinates at the predetermined temperature of dielectric materials. And a resistance film is printed so that it may connect with Electrodes 23a and 26a on the front face of the calcinated layered product, a silver paste is further applied mostly to the predetermined position of the ends of the side of a layered product, the leg side, and a rear face as a ground electrode with an ON appearance terminal on the whole surface, it prints in a firing furnace, and the capacitative-element substrate 2 is formed. In this example, although the green sheet for dummies is one sheet of 2e, this can select the thickness of number of sheets and a sheet suitably if needed for height control. Thus, since the height of a capacitative-element substrate can be set up according to the height by the side of a central conductor assembly so that it may become almost the same when it considers as a layered product, it is effective.
[0016] Moreover, the above-mentioned example does not show an example of this invention, and is not limited to this. this invention can be carried out according to other embodiments. For example, a hole 200 can apply also to a thing with the bottom of the shape of not penetration but a cavity about a capacitative-element substrate.
[0017]
[Effect of the Invention] According to this invention, when a central conductor assembly is held into the through hole of a capacitative-element substrate, among both, there is no level difference etc. and a central conductor and a capacitative-element substrate can be connected with a curtate distance as it is. Moreover, even if ZAIZU of a central conductor is changed and height changes, it becomes possible to connect with a curtate distance similarly by adjusting suitably the laminating number of sheets and sheet thickness of a dummy layer by the side of a capacitative-element substrate, and correspondence becomes easy. Therefore, while being able to perform the miniaturization of a non-reciprocal circuit element, the yield can be improved by suppressing dispersion in a manufacturing process, and the non-reciprocal circuit element of a low cost with little property dispersion can be obtained.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the decomposition perspective diagram showing one example of the non-reciprocal circuit element of this invention.
[Drawing 2] It is the decomposition perspective diagram of the capacitative-element substrate of an example.
[Drawing 3] It is drawing of longitudinal section of a non-reciprocal circuit element.
[Drawing 4] It is the perspective diagram showing an example of the structure of the conventional non-reciprocal circuit element.
[Drawing 5] It is drawing of longitudinal section of the conventional non-reciprocal circuit element.
[Description of Notations]
1 55: Central conductor assembly
2 40: Capacitative-element substrate
3: Resin base
4 53: Permanent magnet
5 61: Metal top case
6 63: Bottom case of a metal
11, 12, 13, 56, 57, 58, 58a, 131: Central conductor
43-45, 47,201-203, 205-207, 21a-23a, 200b, 21c-23c, 200d: Electrode pattern
46,204: Resistance film
41,200: Through hole
2a, 2b, 2c, 2d, 2e: Green sheet
49, 24a, 24b: Through hole
30 64: Grounded plate
31: Resin
32.33: Capacitative-element substrate connection input/output terminal
34: External grounding terminal
35: External I/O terminal
62: The lower part section on a metal case
132: Central conductor grounding section

[Translation done.]

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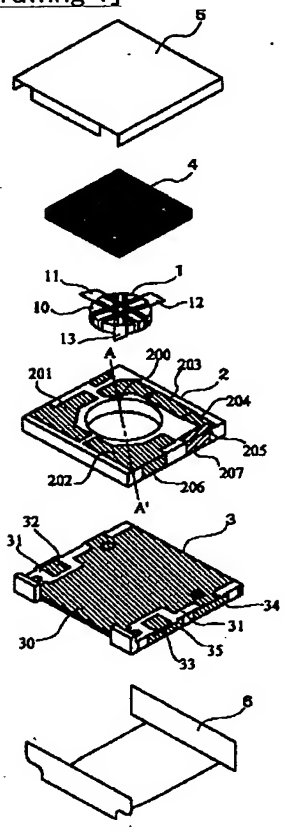
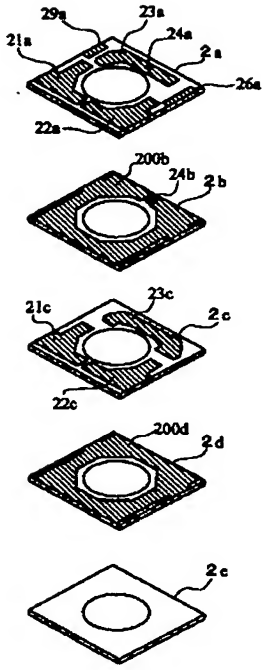
DRAWINGS

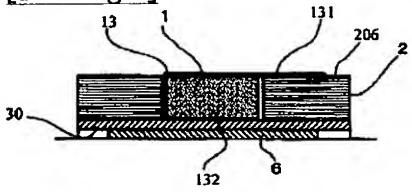
[Drawing 1]



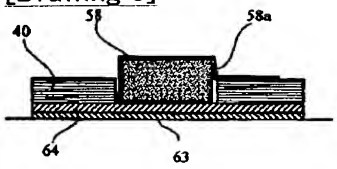
[Drawing 2]



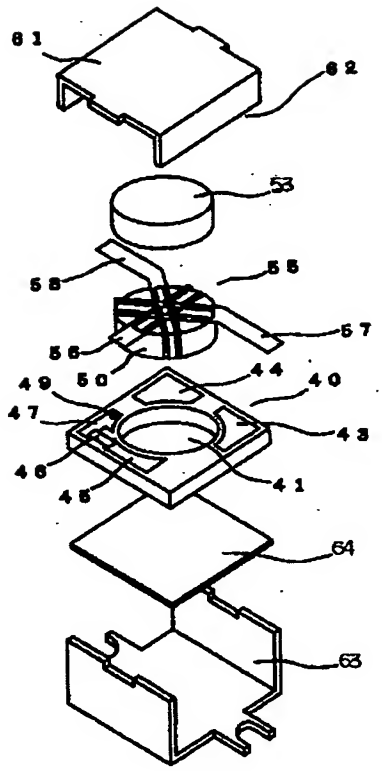
[Drawing 3]



[Drawing 5]



[Drawing 4]



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審査請求　未請求　請求項の数５　ＯＬ　（全６頁）

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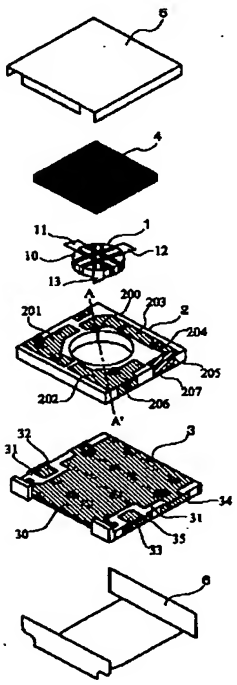
Ｆターム(参考)　5J013 EA01 FA07

(54)【発明の名称】　非可逆回路素子

(57)【要約】
【課題】　本発明は面実装可能な構造で損失ロス低減と小型化を図った非可逆回路素子を提供することを目的とする。
【解決手段】　ガーネット１０と絶縁状態を保って配置された中心導体１１、１２、１３とを有する中心導体組立体１と、略中央に形成した凹穴２００内に中心導体組立体１を収容し、これと電気的に接続された容量素子基板２と、直流磁界を印加する永久磁石４とを有し、これらを磁性ヨークを兼ねる金属製ケース５、６内に配置してなる非可逆回路素子であって、容量素子基板２を積層焼結体で形成し、中心導体組立体１の中心導体の一端を容量素子基板の接続電極部に接続するために、容量素子基板２の接続電極部と中心導体組立体１の高さをほぼ同一高さに設定した非可逆回路素子である。



【特許請求の範囲】

【請求項１】　フェライト及びこのフェライトと絶縁状態を保って配置された中心導体とを有する中心導体組立体と、略中央に形成した凹穴内に前記中心導体組立体を収容し、且つ中心導体組立体と電気的に接続された容量素子基板と、前記中心導体組立体に直流磁界を印加する永久磁石とを有し、これらを磁性ヨークを兼ねる金属製の上下ケース内に配置してなる非可逆回路素子において、前記容量素子基板を積層焼結体で形成し、前記凹穴内に収納された中心導体組立体の中心導体の一端を前記容量素子基板の電極部に接続するために、前記中心導体組立体の高さに対し容量素子基板の電極部高さがほぼ同一高さであることを特徴とする非可逆回路素子。

【請求項２】　前記容量素子基板の電極部と、中心導体の高さの差が０．３ｍｍ以下であることを特徴とする請求項１に記載の非可逆回路素子。

【請求項３】　中心導体が、絶縁シート上に導体で形成されたものであることを特徴とする請求項１又は２に記載の非可逆回路素子。

【請求項４】　前記中心導体組立体が、誘電体または磁性体によるセラミックス積層体で形成されたものであることを特徴とする請求項１乃至３の何れかに記載の非可逆回路素子。

【請求項５】　前記容量素子基板と下側の金属ケースとの間に、導電体板と樹脂枠を一体化した樹脂ベースを配置し、この樹脂ベースの樹脂枠外側面および／または底面に外部実装基板に接続するための電極部が設けてあることを特徴とする請求項１乃至４の何れかに記載の非可逆回路素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、高周波信号に対して非可逆伝送特性を有する非可逆回路素子に関し、具体的には携帯電話などの移動体通信システムの中で使用され、一般にアイソレータやサーキュレータと呼ばれる非可逆回路素子に関するものである。

【０００２】

【従来の技術】非可逆回路素子は、ガーネット等のフェライトに複数の中心導体を交差させて設け、直流磁界を磁石によってフェライトに加え、フェライト内に磁気共鳴回転磁界を生じさせて、ある中心導体に入力された信号を減衰させること無く特定方向の中心導体へ伝送する回路素子である。例えば、アイソレータは、３つの中心導体を交差させ、うち一つを無反射終端とすることにより、他の２つの中心導体間で、特定方向の信号はほとんど減衰させずに通過させるが、逆方向の信号は大きく減衰させるような特性を持たせた非可逆回路素子である。この様な非可逆回路素子は、移動体通信機や携帯電話機等に使用され、送信部及び受信部内での反射波の除去、インピーダンス整合、増幅器・発振器等の安定動作などのために必要不可欠な回路素子となっている。以下集中定数型のアイソレータを例にとって説明する。

【０００３】図４に従来のアイソレータの分解斜視図を示す。この例によれば金属製の下ケース６３の上にアース板６４を配置し、その上に容量素子基板４０が配置される。この容量素子基板４０は１枚の誘電体基板からなり、中央に貫通穴４１を有している。この容量素子基板４０の上面に容量素子を構成する電極パターン４３、４４、４５がそれぞれ形成されており、裏面にはほぼ全面に渡りアースパターンが形成されており、上面の電極パターンとアースパターンの間で共振容量を得ている。この容量素子用電極パターンの一つ４５は、ダミー抵抗４６に接続され、更にダミー抵抗４６はアース電極４７に接続されている。このアース電極４７はスルーホール４９でアース板６４に接続される。この容量素子基板４０の貫通穴４１には中心導体組立体５５が配置される。この中心導体組立体５５はガーネット等のフェライト円板５０を包むように１２０度の間隔で放射状に折り込まれた中心導体５６、５７、５８を有しており、各中心導体間は絶縁されている。そして、その上部に永久磁石５３が接着された金属製の上ケース６１を設け、上ケース６１と下ケース６３をはめ合わせ組み立てられている。ここで中心導体５７、５８の一端部は、上ケース６１と下ケース６３の間６２部分から外部に引き出され入出力端子を構成している。

【０００４】

【発明が解決しようとする課題】上記した従来例では、アイソレータをさらに小型化する場合、コンデンサの寸法を小さくするか、ガーネットの直径を小さくするか、あるいは両方を小さくしなければならない。コンデンサの容量は、

$C = \varepsilon r \cdot \varepsilon 0 \cdot S / d$

と表される。ここで、Ｃはコンデンサの容量、εｒは誘電体の比誘電率、ε０は真空の誘電率、Ｓは電極の面積、ｄは電極間の誘電体の厚さを表す。コンデンサの寸法を小さくすることにより電極の面積Ｓを小さくしても同じ容量を得るためには、比誘電率εｒの大きい誘電体を使用するか、電極間の誘電体の厚さを薄くしなければならない。しかし、比誘電率の大きい誘電体材料は一般に誘電損失も大きい傾向があり、誘電損失が大きいとアイソレータの挿入損失が大きくなるため好ましくない。誘電体の厚さを薄くすると、ガーネットの上面と容量素子基板の上面の段差が大きくなる。これにより製造工程中に例えば、中心導体５８と容量パターン４４の間に隙間が発生し、電気的に接続していない状態、いわゆるオープン不良が発生し易くなる。また、電気的には接続していても、中心導体５８とガーネット５０と容量素子基板４０の間にできる空間の大きさが製造工程中でばらつくため、これがインピーダンスのばらつきとなりアイソレータの挿入損失や動作周波数や入力インピーダンスの

ばらつきの一因となる。

【０００５】また、このような不要な空間を極力小さくし、中心導体と容量パターンの隙間を小さくするために、図５の５８ａに示すように中心導体の一端をガーネットの側面に沿うように折り曲げる、いわゆるフォーミングを行う方法もあるが、工程が増えるためコストが高くなる。また、製造工程におけるフォーミングのための中心導体の折り曲げ角度のばらつきが、上述と同様にアイソレータの挿入損失や動作周波数や入力インピーダンスのばらつきの一因となる。また、製造工程中で中心導体組立体を容量基板素子に挿入後、はんだ硬化途中に中心導体組立体に不均一な力がかかると、中心導体組立体が傾き易く、傾いた状態ではんだを硬化させるとアイソレータの挿入損失が増加し動作周波数がずれる。また、磁石が中心導体組立体に隙間無く接する設計の場合、磁石とガーネットの平行度のばらつきが大きくなり、アイソレータの特性ばらつきの一因となる。

【０００６】一方、アイソレータを小型化するためガーネットの直径を小さくする場合、中心導体とガーネットで構成される中心導体組立体のインダクタンスが小さくなるため、同じ動作周波数にするためにはコンデンサの容量を大きくしなければならない。このため、先述のコンデンサの寸法を小さくする場合と同じ問題が起きる。また、ガーネットの厚さを厚くすると中心導体組立体のインダクタンスを大きくすることができるが、これもガーネットの上面と容量素子基板の段差が大きくなるため好ましくない。また、上記した従来例では面実装が可能な構造でなく小型化に適さない。

【０００７】以上のことから、本発明はオープン不良や特性ばらつきの低減を図り歩留まりを向上させ、低コスト化を図ること、さらに面実装可能な構造とすることによって小型低背化した非可逆回路素子を提供することを目的とする。

【０００８】

【課題を解決するための手段】本発明は、フェライト及びこのフェライトと絶縁状態を保って配置された中心導体とを有する中心導体組立体と、略中央に形成した凹穴内に前記中心導体組立体を収容し、且つ中心導体組立体と電気的に接続された容量素子基板と、前記中心導体組立体に直流磁界を印加する永久磁石とを有し、これらを磁性ヨークを兼ねる金属製の上下ケース内に配置してなる非可逆回路素子において、前記容量素子基板を積層焼結体で形成し、前記凹穴内に収納された中心導体組立体の中心導体の一端を前記容量素子基板の電極部に接続するために、前記中心導体組立体の高さに対し容量素子基板の電極部高さがほぼ同一高さである非可逆回路素子である。

【０００９】ここで、容量素子基板の電極部と、中心導体の高さの差が０．３mm以下であることがより望ましく、中心導体は絶縁シート上に導体で形成されたものであっても良い。また、中心導体組立体が誘電体または磁性体によるセラミックス積層体で形成することもできる。また、容量素子基板と下側の金属ケースとの間に、銅板などの導電体板と樹脂枠を一体化した樹脂ベースを配置し、この樹脂ベースの樹脂枠外側面および／または底面には外部実装基板に接続するための電極部が設けてあるような樹脂ベースを用いることが望ましい。

【００１０】本発明において、まず容量素子基板はグリーンシートを積層し、焼結した一体焼結型の積層体構造とした。これによって比較的誘電損失の大きい高誘電率材料を用いることなく、小さい面積で高容量かつ低損失のコンデンサを得ることができる。なおかつ、実質的にコンデンサ容量に寄与しないダミー層を同時に積層することにより容量素子基板の厚さを中心導体組立体の高さに合うように設計することができる。その結果、中心導体組立体と容量素子基板の上面電極はほぼ面一に構成でき、３本の中心導体は何れも同一長さの短かいストリップラインを使用して均一に接続できる。また、中心導体の折り込みが正確にできる。よって、挿入損失や動作周波数や入力インピーダンスのバラツキも少ないものとなった。また、樹脂ベースには、容量素子基板と接続する薄い導電板による入出力端子とアース板を備え、各々面実装に適した形状寸法の外部電極と一体となっている。これらの電極は左右両端の樹脂枠により堅持されている。従って、実装基板上への取り付けによるグランド接続や入出力接続が確実で容易なものとなる。また、積層体に直接外部端子を形成する場合と比較して、外部端子の耐はんだ食われ性、固着性に優れ信頼性の高いアイソレータを提供できる。

【００１１】

【発明の実施の形態】以下、本発明の非可逆回路素子の実施例を図面を参照して説明する。図１は本発明の非可逆回路素子の一実施例を示す分解斜視図である、図２は容量素子基板の分解斜視図である。図３は非可逆回路素子の部分的な縦断面図である。先ず、図１よりこの非可逆回路素子は、中心導体組立体１、中央部の貫通穴に前記中心導体組立体１を組み込むようになし、上面に入出力電極や抵抗膜で形成した抵抗体を有する容量素子基板２、中心導体組立体１に直流磁界を印加する永久磁石４、磁性ヨークを兼ねる金属製の上ケース５と同じく下ケース６、及び容量素子基板２と下ケース６との間にありＣｕ板等の導電板３０、３２、３３を樹脂枠３１内に組み入れた樹脂ベース３とからなっている。樹脂ベース３は下ケース６の中央部の金属部分に嵌まるようになっており、左右の樹脂枠３１は面実装可能なように実装基板面に面している。つまり樹脂ベース３の左右端部にある４つの外部電極のうち３４とそれに対向する電極（図示せず）は導電板３０と導通しアース端子となり、外部電極３５とそれに対向する電極（図示せず）は中心導体が接続される容量素子の裏面に形成された端子電極（図

示せず）と各々接続される端子３３、３２と接続しており、入出力端子となって実装基板に面実装される。樹脂ベース３により実装基板上への取り付けによるグランド接続や入出力接続が確実で容易なものとなる。また、積層体に直接外部端子を形成する場合と比較して、外部端子の耐はんだ食われ性、固着性に優れ信頼性の高いアイソレータを提供できる。

【００１２】中心導体組立体１は、従来と同様ガーネット等のフェライト１０に３本のストリップラインからなる中心導体１１、１２、１３を１２０度間隔で且つ絶縁体を介して織り込んだものである。例えば図３に示すように中心導体１３の一端１３２はガーネットの下面側で樹脂ケースの導電板３０に半田付けされており、導電板３０は下ケース６に接続している。もう一端１３１は上面にあり放射状に延出し出力電極となる。他の中心導体も同様で入力電極とロード電極を構成している。これらの上面側の端子は直線的に延ばしただけのもので中心導体の一端１１、１２、１３をさらにガーネットの側面に沿うように折り曲げる、いわゆるフォーミング工程は不要である。尚、中心導体は有機樹脂などの絶縁シート上に銅箔などの導体で形成されたものや、誘電体または磁性体による積層体で形成されたものを用いることもでき、これにより組立て工数を削減しさらにコスト低減をはかることもできる。また、中心導体組立体１全体を磁性体のグリーンシートを積層して形成することもでき、これによればさらに中心導体組立体を薄くすることが出来る。

【００１３】次に容量素子基板２は、誘電体グリーンシートを積層した一体型の積層焼結体からなり、中央部には貫通穴２００を有し、上面には整合用のコンデンサを形成するための入力容量電極２０１、出力容量電極２０２とロード電極２０３及びアース電極２０５と終端抵抗２０４が印刷で形成されている。容量素子基板２の外側面には基板上面の電極と内部電極と基板裏面の電極を接続する側面電極２０６、２０７及びこれらの対極にある側面電極（図示せず）が設けられている。容量素子基板の裏面には、ほぼ全面にアース電極が設けられ、両端部には樹脂ベース３側の端子電極３２、３３と接続する入出力端子が設けられている。そして入出力電極またはロード電極とアース電極との間で共振容量が得られるようになっている。上記中心導体組立体１及び容量素子基板２はそれぞれ別個に製造し、中心導体組立体１を容量素子基板２の貫通穴２００内に嵌合装着させた後、各中心導体１１、１２、１３の一端がガーネットの下で接続されている導電板をアース導電板３０に、他端を容量素子基板２の上面電極２０１、２０２、２０３にそれぞれ半田付けで電気的に接続する。このとき中心導体組立体１と容量素子基板２の高さはほぼ同一に設定されているので図３に示すように直線状に延びたストリップラインの一端１３１を電極２０６上に隙間なく接続できる。従って、組立てのばらつきを低減し正確に出来るようになった。

【００１４】次に、容量素子基板２を図２に示す分解斜視図で説明する。本例の容量素子基板２は第１、第２、第３、第４及び第５の誘電体層２ａ、２ｂ、２ｃ、２ｄ及び２ｅとからなる多層構造である。まずガラスを主成分とした第１～第５の誘電体層２ａ～２ｅ用のグリーンシートをドクターブレード法にて作製し、所定の位置にスルーホールを開ける。第１の誘電体層２ａのグリーンシート上には、所定の整合容量が得られるように第１の入力容量電極２１ａ、第１の出力容量電極２２ａ、第１のロード容量電極２３ａ及び接地電極２６ａを銀ペースト等の導電材で印刷する。また、電極２３ａにはスルーホール２４ａが形成されている。第２の誘電体層２ｂのグリーンシート上にはグランド電極２００ｂを形成しておく。また、第１の誘電体層２ａのスルーホール２４ａと対応合致する位置にスルーホール２４ｂを形成する。第３の誘電体層２ｃのグリーンシート上には第２の入力容量電極２１ｃ、第２の出力容量電極２２ｃ及び第２のロード容量電極２３ｃを同様に印刷し、第４の誘電体層２ｄのグリーンシート上には第２の誘電体層と同様にグランド電極２００ｄを印刷形成する。第５の誘電体層２ｅはダミーのグリーンシートでその上には電極は印刷されていない。

【００１５】次いで、第１～第５の誘電体層２ａ～２ｅのグリーンシートを順次積層し熱圧着して一体型の積層体を得る。得られた積層体に中心導体組立体１が嵌合されるべき貫通穴２０を打ち抜いて形成する。その後、積層体を所定の大きさに切断し誘電体材料の所定温度で焼成する。そして、焼成した積層体の表面に電極２３ａと２６ａに接続するよう抵抗膜を印刷し、さらに積層体の側面と脚部側面および裏面の両端の所定位置に入出端子とほぼ全面にアース電極として銀ペーストを塗布し焼成炉にて焼きつけて容量素子基板２を形成するものである。本例ではダミー用のグリーンシートは２ｅの一枚であるが、これは高さ調節の必要に応じて枚数およびシートの厚さは適宜選定することができる。このように積層体とした場合は、中心導体組立体側の高さに応じて容量素子基板の高さをほぼ同一となるように設定することが出来るので効果的である。

【００１６】また、上記した実施例は本発明の一例を示すものであってこれに限定されるものではない。本発明は他の実施態様によっても実施することが出来る。例えば、容量素子基板について穴２００が貫通でなくキャビティ状の底があるものにも適用できる。

【００１７】

【発明の効果】本発明によれば、容量素子基板の貫通穴の中に中心導体組立体を収容したとき、両者間に段差などが無くそのまま最短距離をもって中心導体と容量素子基板を接続することができる。また、中心導体のザイズ

が変更され高さが変わっても容量素子基板側のダミー層の積層枚数およびシート厚さを適宜調整することで同様に最短距離を持って接続することが可能となり対応が容易となる。よって、非可逆回路素子の小型化ができると共に、製造工程におけるばらつきを抑制することで歩留まりを向上し、特性ばらつきの少ない低コストの非可逆回路素子を得ることができる。

【図面の簡単な説明】

【図１】本発明の非可逆回路素子の一実施例を示す分解斜視図である。

【図２】実施例の容量素子基板の分解斜視図である。

【図３】非可逆回路素子の縦断面図である。

【図４】従来の非可逆回路素子の構造の一例を示す斜視図である。

【図５】従来の非可逆回路素子の縦断面図である。

【符号の説明】

１、５５：中心導体組立体

２、４０：容量素子基板

３：樹脂ベース

４、５３：永久磁石

５、６１：金属上ケース

６、６３：金属下ケース

１１、１２、１３、５６、５７、５８、５８ａ、１３１：中心導体

４３～４５、４７、２０１～２０３、２０５～２０７、２１ａ～２３ａ、２００ｂ、２１ｃ～２３ｃ、２００ｄ：電極パターン

４６、２０４：抵抗膜

４１、２００：貫通穴

２ａ、２ｂ、２ｃ、２ｄ、２ｅ：グリーンシート

４９、２４ａ、２４ｂ：スルーホール

３０、６４：アース板

３１：樹脂

３２．３３：容量素子基板接続入出力端子

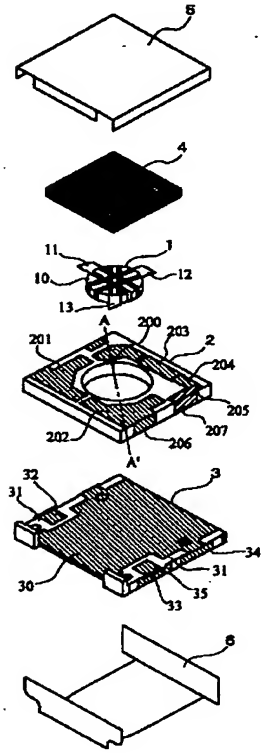
３４：外部アース端子

３５：外部入出力端子

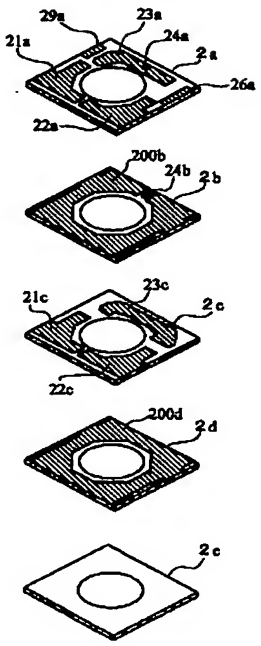
６２：金属ケース上の下方部

１３２：中心導体接地部

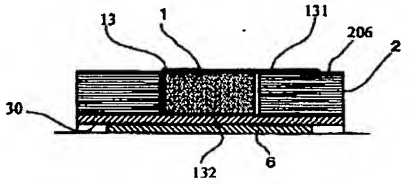
【図１】



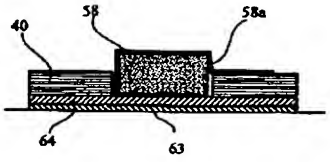
【図２】



【図３】



【図５】



【図４】